Forest Health Protection
Pacific Southwest Region

Date: April 5, 2019
File Code: 3400

To: Ann Carlson, Forest Supervisor, Mendocino National Forest

Subject: Interim report for "Evaluation of Emamectin Benzoate, Imidacloprid and Paclobutrizol for Control of Cone and Seed Pests and Improve Seed Production in a Conifer Seed Orchard"

Following the site visit in 2018 (report NC18-006) and the 2018 Pesticide Users Conference, Don Grosman (Arborjet Inc.) proposed a field trial at the Chico Seed Orchard (CSO) of tree injections to reduce the risk of seed loss due to cone and seed insects and provide an option for combatting pesticide resistance. Lisa Crane, CSO Manager (Mendocino National Forest), started the process that may lead to adding tools to combat coneworms and seed bugs, the worst pests in the seed orchard and a growth regulator to improve cone production. Forest Health Protection (FHP) has reviewed the Pesticide Use Proposal and study protocols (Appendix A) and is assisting with the project. The objectives are:

1) To evaluate the efficacy of three formulations of TREE-äge® (emamectin benzoate) in reducing seed crop losses due to coneworm (*Dioryctria* sp.) in Douglas-fir (*Pseudotsuga menziesii*) seed orchards
2) To evaluate the efficacy of two formulations of IMA-jet® (imidacloprid) in reducing seed crop losses due to seed bug (*Leptoglossus* sp.) in ponderosa pine (*Pinus ponderosa*) seed orchards
3) To evaluate ability of ShortStop® (paclobutrazol) to increase Douglas-fir and ponderosa pine flower and subsequent seed production

Arborjet Inc. is providing the chemicals and labor free-of-charge to the Forest Service in exchange for the publication privileges. Don Grosman came to CSO March 19, 2019 for four days to provide the treatments.

Background

The 209-acre Chico Seed Orchard, formerly Chico Genetic Resource and Conservation Center (GRCC), was first was acquired by the US Forest Service in 1974 to develop and produce genetically improved plant material for reforestation in the Pacific Southwest Region. Currently, the facility produces genetically improved conifer seeds for reforestation and restoration (primarily ponderosa pine and Douglas-fir) and serves as a resource for research in plant genetics and forest health issues including tree disease resistance.

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In 2009, the integrated pest management (IPM) plan was revised for the GRCC to provide guidance for controlling pests at tolerable levels by strategic and planned use of a variety of preventative, suppressive, and regulatory methods consistent with seed orchard management goals. One of the pests targeted by the IPM plan was coneworms, *Dioryctria* sp., specifically on Douglas-fir and seed bugs, *Leptoglossus* sp., in ponderosa pine. Coneworm infestations have been a continuing problem at the CSO often drastically reducing viable seed production.

Observations

Currently the CSO uses ground-based high-pressure applications of Asana XL®, esfenvalerate. The pesticide is sprayed at night four times each season. Walking through the seed orchard, it is evident that the grafted trees in many of the established orchards are getting too tall for the current method of delivery to effectively reach the upper crown with the current pesticide. There were many cones left on the trees due to insect infestations in 2018. The use of the same class, in fact the exact same pesticide four times a year for the past twelve years has most likely led to insect resistance.

Twelve clones of Douglas-fir were chosen with five ramets each to use for the trials (12 clones, 5 reps each = 60 trees). The most important concerns in choosing trees was each clone needed to have at least five ramets between four and twenty inches in diameter. Two of these clones are known early flowerers. The evidence of flowers was used to indicate the future presence of cones in the trees (Figure 1). The trees were then randomly (random by clone) divided to have nearly equal average diameters for each treatment.

Figure 1. Douglas-fir flowers.

The Douglas-fir and ponderosa pine orchard blocks had been treated as usual in 2018 with airblast sprays of Asana XL. All treatments were administered as described in the project protocols in Appendix A in March of 2019 (Figure 2). Trees were treated via trunk injection (Arborjet's Quickjet Air). The number of injection sites determined by DBH/2. At the time of treatment, 3/8" diameter holes were drilled to a 3.5 inch depth at 6" spacing at a height of 18 inches or less on the trunk and a 3/8 inch Arborplug was installed through which systemic insecticide was applied into the xylem of each tree. ShortStop was applied to get maximum flowering and subsequent cone production.

The upcoming customary treatments of Asana XL for 2019 will be staggered so as not to cover the study trees. The treatments will be evaluated using the experimental design protocol described by DeBarr (1978). In October 2019 and 2020, the number of surviving conelets and cones will be counted. Also, a subsample (~200) of 2nd year cones will be harvested from each tree. The level of cone damage and/or mortality will be determined. Presence of other insect infestation will also be assessed.

Figure 2. Chico Seed Orchard technician applying TREE-age G4 (4% emamectin benzoate (EB), 5 ml/in DBH by Quik-jet Air (QJA) micro injection into Douglas-fir clone.

Discussion

Broadcast sprays of contact insecticides are the most commonly used insecticide application technique against a variety of *Dioryctria* species. Currently the CSO uses ground-based high-pressure applications of Asana XL. The pesticide is sprayed at night four times each season. This approach has led to pesticide resistance in the insect. A better approach would be to use alternating products for each spray in a season or to alternate chemistries (chemical classes). However, proximity to the creek and school, as well as other neighbors, limits certain chemicals that may be highly effective in other regions from being used at the site.

The possible use of systemic insecticides was discussed at the meeting in 2018. Advantages of systemic insecticides, which can translocate into cones and kill seed-feeding insects, include reduced non-target mortality and elimination of problems associated with drift and inconsistent deposition. The efficacy of injection of loblolly pine stems with emamectin benzoate (EB) was tested in Texas (Grosman et al., 2002). A single application of EB reduced damage from *Dioryctria* species by 94 - 97% over a two-year period. Further studies continued to show reduced damage to cones by coneworms with protection equal with spring or fall treatments and added protection against other insect pests (Cook et al. 2013[a], Cook et al. 2013[b]). Systemics are costly and labor intensive but have little to no effect on people and animals in the orchard. It was discussed that an option for their use would be to inject 1/3 of the trees, the highest

valued clones first, each year with the anticipation of getting up to 3 years of control. Asana XL would still be in the tool box for spot treatments and to cycle in and out to prevent pesticide resistance.

Conclusions

Conifer seed orchards, like CSO, produce high-quality seed from selected genotypes of important tree species for the reforestation and restoration of forest lands. The genetically improved seed has such a high economic value that there is very little tolerance of damage.

Pesticide resistance has become a problem with the same chemical used over and over to control a particular pest. The goal of successful resistance management is to reduce populations of pests, whether they are resistant or susceptible to pesticides. The general recommendation when using pesticides is to alternate pesticides of different chemistry and modes of action. This recommendation is based on the theory that the likelihood of a population developing resistance to two or more pesticides, each from a different chemical group with different modes of action, is significantly less than the likelihood that a population could develop resistance to only one of the pesticides. Therefore, individuals in the pest population resistant to one of the pesticides would be killed upon exposure to the (different) partner pesticide.

There are alternatives to the single chemical currently being used at CSO. There are opportunities to add to the tools through a letter to the file or an update to the current EIS. This opportunity to bring in researchers from private industry to perform field trials of newer systemics is a great first step. If successful, I suggest that the CSO schedule a meeting with Regional Geneticists, Silviculturists, Entomologists, Pathologists, and Pesticide Coordinators to discuss the current and future needs and direction of the seed orchard and revise the current IPM plan to incorporate new tools for cone and seed protection.

If you have any questions regarding this report and/or need additional information, please contact Cynthia Snyder at 530-226-2437.

/s/ Cynthia Snyder

CC: Joe Sherlock, Chuck Frank, Lisa Crane, Andrew Mishler, Chris Losi, Sheri Smith, Phil Cannon, Sherry Hazlehurst, and Chris Fischer

References:

Cook [a], S.P., B.D. Sloniker, and M.L. Rust. 2013. Using systemically applied insecticides for management of ponderosa pine cone beetle and *Dioryctria* coneworms in seed orchards. West. J. Appl. For. 28(2): 66-70.

Cook [b], S.P., B.D. Sloniker, and M.L. Rust. 2013. Efficacy of two bole-injected systemic insecticides for protecting Douglas-fir from damage by Douglas-fir tussock moth and fir coneworm. West. J. Appl. For. 28(4): 166-169.

Grosman, D.M., W.W. Upton, F.A. McCook, and R.F. Billings. 2002. Systemic insecticide injections for control of cone and seed insects in loblolly pine seed orchards — 2 year results. Southern Journal of Applied Forestry, 26: 146–152.

Appendix A

Evaluation of Emamectin Benzoate, Imidacloprid and Paclobutrizol for Control of Cone and Seed Pests and Improve Seed Production in a Conifer Seed Orchard

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Cooperator: Lisa Crane, Seed Orchard Manager, USDA Foresest Service, M: 530/720-0514, E: lcrane@fs.fed.us.

Objectives

1) Evaluate the efficacy of three formulations of emamectin benzoate in reducing seed crop losses due to coneworm, seed chalcid and/or gall midge in Douglas-fir seed orchards,
2) Evaluate the efficacy of two formulations of imidacloprid in reducing seed crop losses due to seed bug or seed chalcid in ponderosa pine seed orchards and
3) Evaluate ability of paclobutrazol to increase Douglas-fir and ponderosa pine flower production and subsequent seed production.

Methodology

The study will be conducted at the Genetic Resource and Conservation Center Seed Orchard, Chico, CA in two separate blocks, Douglas-fir and ponderosa pine. The Douglas-fir orchard block had been protected in 2018(?) with airblast sprays of Asana XL. In March (?) 2019, 5 ramets from each of 6-10 Douglas-fir clones and 3 ramets of 6-10 ponderosa pine clones will be selected. The treatments will be evaluated using the experimental design protocol described by Gary DeBarr (1978) (i.e., randomized complete block with clones as blocks). The treatments in the Douglas-fir block include:

1) TREE-age G4 (4% emamectin benzoate (EB), 5 ml/in DBH by Quik-jet Air (QJA) micro injection
2) TREE-age S50 (4% EB) 5 ml/in DBH by QJA or
3) TREE-age R10 (9.7% EB) 2.1 ml/in DBH by QJA
4) TREE-age G4 (5 ml/in DBH by QJA) + ShortStop (22% paclobutrazol) (17ml/inch DBH (4.0g ai/inch))
5) Check

The treatments in the ponderosa pine block include:

1) IMA-jet (5% imidacloprid (IJ), 4 ml/in DBH by QJA
2) IMA-jet (4 ml/in DBH by QJA) + ShortStop (22% paclobutrazol) (17ml/inch DBH (4.0g ai/inch))
3) Check

Treatment 1-4 in Block1 and treatments 1&2 in Block 2 will be applied using the Quikjet Air micro-injection system (Arborjet Inc) to selected ramets in March 2019 (just after a heavy rain, if possible). The volume of insecticide/ShortStop solution applied will be based on the diameter at breast height (DBH) of each treatment tree, so the diameter of all study trees to be injected should be measured prior to the injection date.

Trees will be treated with insecticides via trunk injection (Arborjet's Quickjet Air) in the early spring (March) 2019. The number of injection sites is determined by DBH/2. At the time of treatment, 3/8" diameter holes will be drilled to a 3.5 inch depth at 6" spacing at a height of 18 inches or less on the trunk. A #4 (3/8") Arborplug will be installed before application of systemic insecticide into the xylem of each tree (there is no exposure to people or animals with either application technique). The time required to treat each tree will be recorded. In June 2019 and 2020, the number of conelets and cones will be counted on 5 flagged branches. In October 2019 and 2020, the number of surviving conelets and cones will be counted. Also, a subsample (~200) of 2nd year cones will be harvested from each tree. The level of cone damage and/or mortality will be determined. Presence of other insect infestation will also be assessed.

Trees will be treated with the plant growth regulator (ShortStop) via basal drench in the early spring (March) 2019. A shallow trench will be dug around the base of each study tree. One part ShortStop (17ml/inch DBH) will be diluted in 11 parts water = 200 ml dilution/inch DBH. The dilution is poured into the trench and allowed to absorb. The soil is placed back into the trench. Note: the per acre limit for ShortStop is 2 lb ai/Acre/year for general use like turf. This equates to 4 grams ai per inch of tree diameter per year.

To improve translocation of products we may apply Hydretain ES Plus Granular OC to all study trees. This product is applied at a rate of 1.5 to 2 pounds for each caliper inch. Apply evenly from the base of the tree just past the drip line for existing trees. Apply water over granule.

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Crop Survival. Cone survival will be evaluated in 2001 and 2002 (if warranted) by tagging five or more branches on each tree (total of at least 50 cones) within one month of peak pollen flight (early April). All counts should be completed within a one week period. Counts of surviving cones from these branches will be made at the end of the growing season, as close to cone harvest as possible (late September). Cone survival reflects protection from coneworms.

Cone Yields and Damage. Yields of healthy and damaged cones will be determined by collecting ~200 cones on each sample ramet at harvest. These cones will be sorted into two groups: "healthy-undamaged" and "damaged". Each cone will be examined carefully, by turning it several times to look for holes, "insect frass", brown or discolored patches of scales, dead tips, and distorted cones. Cones counted as healthy should be damage-free. Questionable cones

should be placed with the damaged cones. The number of healthy and damaged cones will be recorded for each sample ramet in the field. Damaged cones from each ramet will be placed in an individual cloth bag. Bags of damaged cones should be placed in cold storage (at least 45° F or below) until they can be examined and sorted into several specific damage classes (small dead, large dead, grean infested and other).

Seed analysis. Ten cone samples will be picked at random from the "healthy" cones collected from each ramet. These clones will be used for seed analysis. It is very important that these cones be examined carefully and are free of coneworm attacks. Ten cone samples will be placed in small cloth bags (rice bags turned inside out) and labeled by orchard, block, clone, ramet, and treatment. The bags should be tied as close to the end as possible to allow maximum room for cone expansion. The bags of 10-cone samples will be subjected to the standard after-ripening procedures to insure proper cone opening. The seed will be dewinged, cleaned and radiographed by ramet. Total, filled, empty, insect-damaged seed will be counted.

References

DeBarr, G.L. 1978. Southwide test of carbofuran for seedbug control in pine seed orchards. USDA For. Serv. Res. Pap. SE-185. 24 p.

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Grosman, D., W. Upton, A. Mangini, C Rosier, T. Slichter, J. Tule and J Watkins. 2007. Systemic insecticide injections: New, effective option for protecting pine seed orchard crops from insect pests. Proceedings of the Joint Meeting of the Southern Forest Tree Improvement Conference and Western Forest Genetics Association. Galveston, TX. June 19-22, 2007.